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RESEARCH MEMORANDUM

RESULTS OBTAINED DURING A DIVE RECOVERY OF THE BELL XS-1 AIRPLANE TO HIGH LIFT COEFFICIENTS AT A MACH NUMBER GREATER THAN 1.0

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RESEARCH MEMORANDUM

RESULTS OBTAINED DURING A DIVE RECOVERY OF THE BELL XS-1 AIRPLANE TO HIGH LIFT COEFFICIENTS AT A MACH NUMBER GREATER THAN 1.0

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SUMMARY

The U. S. Air Force is undertaking an accelerated flight-test program on the Bell XS-1 cooperatively with the NACA; a U. S. Air Force pilot is flying the airplane and the NACA is reducing and analyzing the data obtained from NACA instrumentation. This paper presents measured quantities obtained during a dive recovery at a Mach number greater than 1.0.

The data obtained show that it is possible to obtain fairly high load factors with the airplane at Mach numbers greater than 1.0 if the stabilizer is used for longitudinal control. Lift coefficients approaching low-speed maximum-lift values have been obtained at a Mach number of 1.1 with no indication that these values are the maximum obtainable for the airplane. At the Mach number and lift coefficient reported, there was little or no buffeting.

INTRODUCTION

An accelerated flight program on the XS-1 airplane through the transonic-speed range is being made cooperatively by the U. S. Air Force and the NACA. The airplane is flown by a U. S. Air Force pilot and the data reduction and analysis are made by NACA personnel from NACA instrumentation. Data obtained from flights of the accelerated program up to a Mach number of 1.25 have been reported in references 1 and 2.

Although higher Mach numbers than reported in reference 2 have not been obtained in recent flights due to faulty rocket operation, the airplane has been maneuvered to fairly high normal accelerations at high Mach numbers. Reported herein are measured quantities obtained during a dive recovery at a Mach number greater than 1.0.

SYMBOLS

H	pressure altitude corrected for static-pressure error, feet
M'	recorded Mach number corrected for static-pressure error
n	normal acceleration in g's
S	wing area, square feet
C_{N_A}'	airplane normal-force coefficient $\left(\frac{nW}{q'S}\right)$
W	gross weight of airplane, pounds
q'	impact pressure corrected for static-pressure error, pounds per square foot

TEST AIRPLANE AND INSTRUMENTATION

The Bell XS-1 flown in these tests is a rocket-propelled research airplane having an 8-percent-thick wing and a 6-percent-thick horizontal tail. A three-view layout of the airplane is shown in figure 1. The weight conditions of the airplane during flight are:

Launching weight, pounds	12,365
Launching center-of-gravity position, percent M.A.C.	22.1
Landing weight, pounds	7,115
Landing center-of-gravity position, percent M.A.C.	25.3

Airspeed, altitude, normal, transverse and longitudinal acceleration were recorded internally on standard NACA instruments. In addition, airspeed, altitude, normal acceleration, elevator force, and elevator, stabilizer and right aileron angles were telemetered to a ground station.

The elevator angles were measured relative to the stabilizer, and the stabilizer angles were measured relative to the airplane center line. The aileron angles were measured relative to the neutral position.

A calibration of the pitot-static head was made during the flight using the radar altitude method (reference 3). The accuracy of the Mach numbers reported herein is about ±0.01 for Mach numbers below 1.02 and approximately ±0.04 for Mach numbers above 1.02.

In addition to the above instrumentation, a 60-cell pressure manometer was installed to record chordwise surface pressure distribution over one spanwise station of the wing. Reduction of these data is now being completed.

TESTS AND RESULTS

Since issuance of reference 2, an attempt has been made to attain higher Mach numbers at an altitude range of 45,000 to 50,000 feet. In order to obtain these higher Mach numbers, a four-rocket flight would be necessary. During the reported flight it was impossible to get all four rockets operating simultaneously and hence the pilot dived the airplane from 47,000 feet with three rockets on in order to obtain high speeds. At approximately 36,000 feet, it was indicated to the pilot that the terminal Mach number had been reached for the power condition and dive angle existing. The pilot reported that full-up elevator was applied and that control effectiveness appeared to be small. Therefore, the horizontal stabilizer was used to complete the recovery from the dive. A time-history of the measured quantities during the recovery is presented in figure 2.

It may be noted in figure 2 that the airplane did respond to elevator movement during the dive, although the elevator deflections and control forces required to produce the response were large. A lift coefficient of approximately 0.8 was obtained at a corrected Mach number of 1.13, and there was no indication that this was the maximum lift obtainable for the airplane at this Mach number. The pilot reported that there was no evidence of buffeting during the dive or pull-up. Buffeting as shown by the recorded acceleration was slightly perceptible but unmeasurable. An airspeed calibration was obtained only to time 220.8 seconds; hence, corrected values of altitude, Mach number, and airplane normal-force coefficient are not indicated on the figure after this time. However, it is known that the Mach number fell off to approximately 0.90 near the end of the record.

CONCLUSIONS

Data presented herein show that, for the XS-1 with 8-percent wing:

1. It is possible to obtain fairly high load factors with the XS-1 at Mach numbers greater than 1.0 if the stabilizer is used for longitudinal control.

2. Lift coefficients near low-speed maximum lift values were obtained at Mach numbers of 1.1. There was no indication that these values were the maximum obtainable for the airplane.

3. From the pilot's report and recorded acceleration, there was little or no buffeting at any lift coefficients reported above Mach numbers of 1.0.

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ABSTRACT

Measured quantities are presented which were obtained on the Bell XS-1 airplane with an 8-percent-thick wing and a 6-percent-thick horizontal tail during a dive recovery at a Mach number greater than 1.0. The data obtained show that it is possible to obtain fairly high load factors with the airplane at Mach numbers greater than 1.0 if the stabilizer is used for longitudinal control. Lift coefficients approaching low-speed maximum-lift values have been obtained at a Mach number of 1.1 with no indication that these values are the maximum obtainable for the airplane. At the Mach number and lift coefficient reported, there was little or no buffeting.

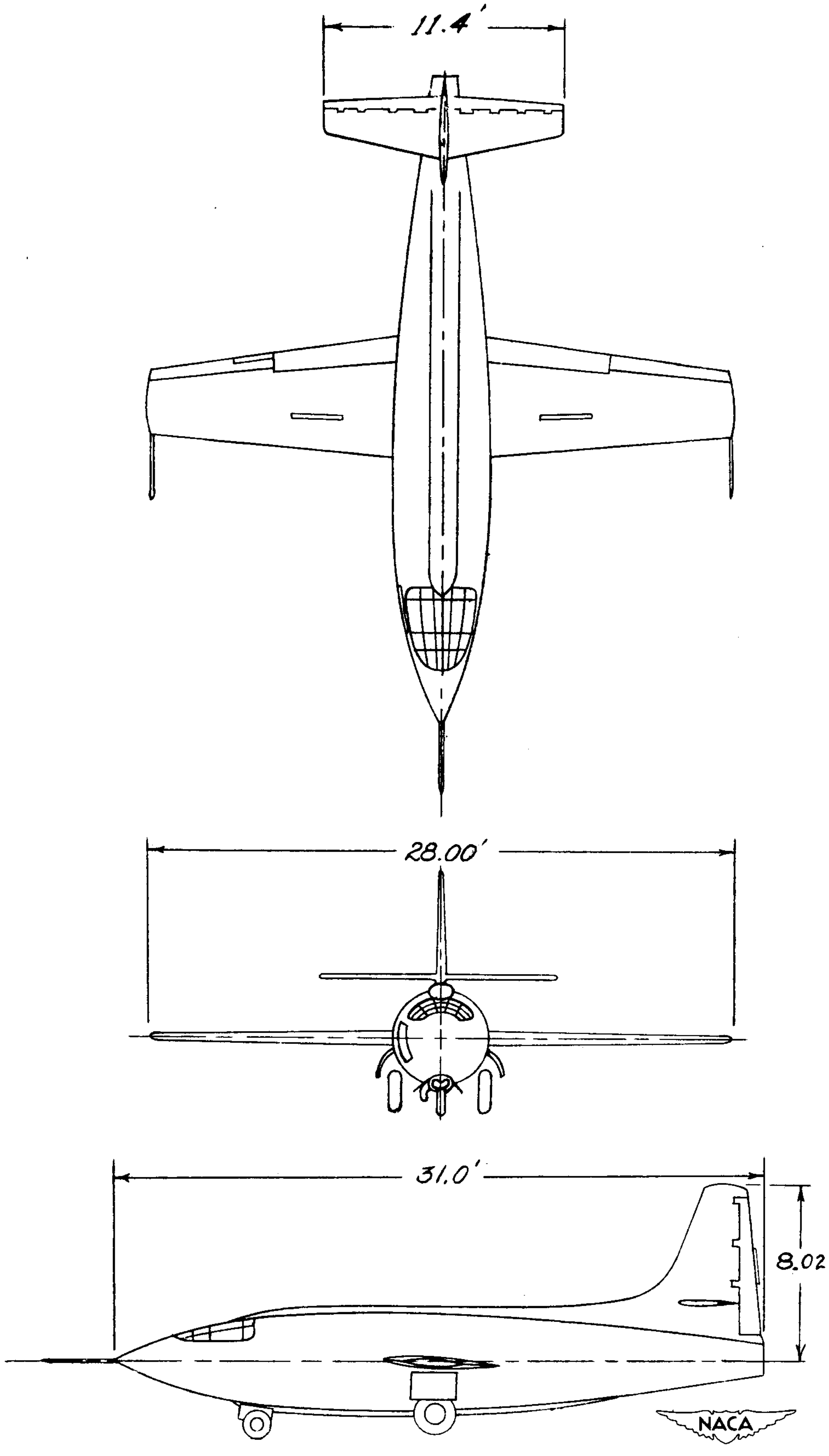

Figure 1.- Three view drawing, XS-1 airplane.

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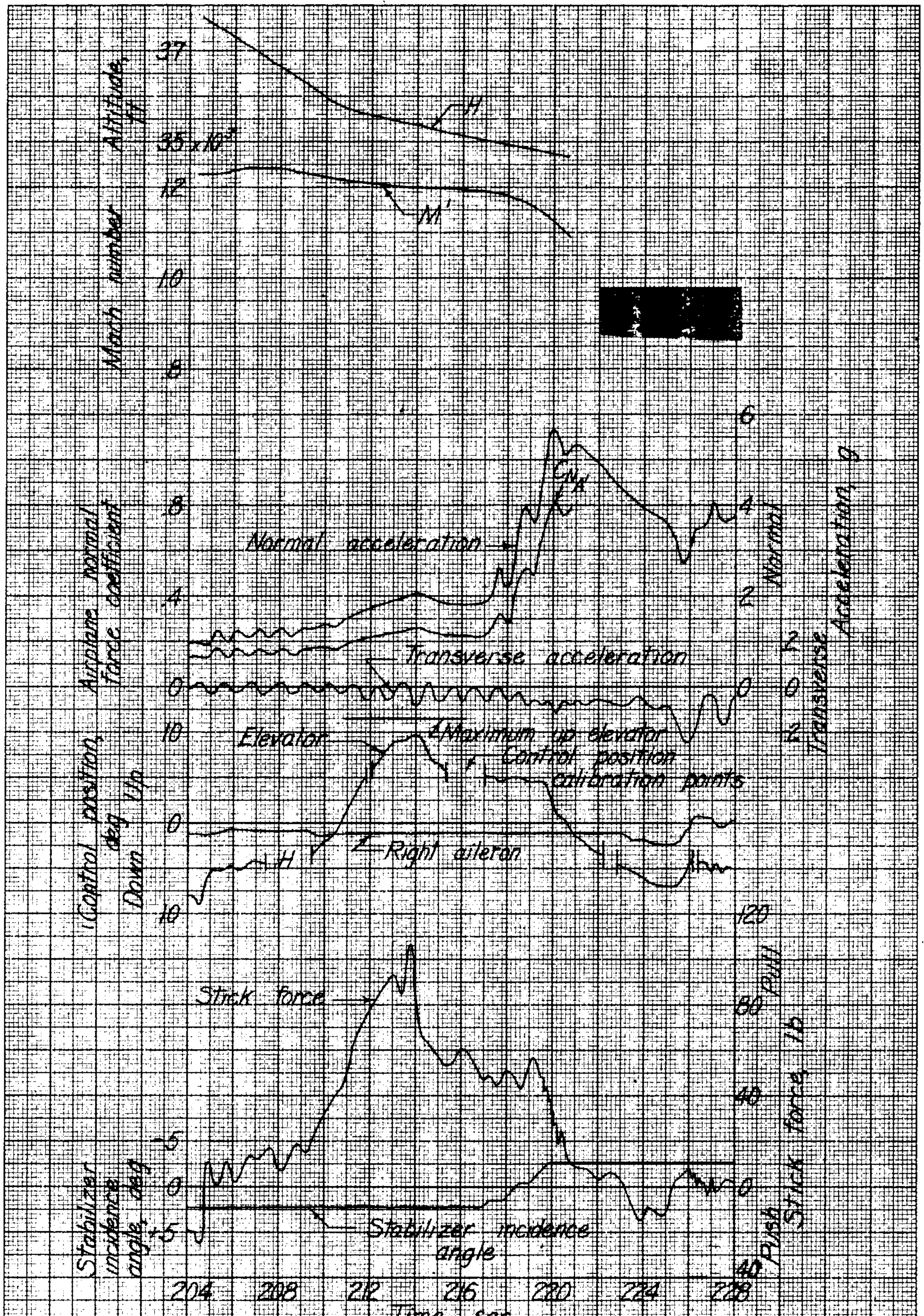

Figure 2. Time history of measured quantities during dive recovery at Mach numbers above 1.0 Bell XS-1, 8% Wing, Flt No 18.

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